



Fuel from the Sky

Solar Power's Potential for Western Energy Supply

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RDI Consulting

Overview of Services

RDI Consulting/Platts
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- One of the countries leading energy consulting firms
- Publish annual whole power price forecasts
(*Outlook for Power in North America*)
- Have conducted due diligence studies on over fifty new power plants in recent years
- Forecast near-term demand and supply balance (*Booms and Busts*)
- Provide plant valuation for refinancing and sales & acquisitions
- Experts on new power plant development in the U.S. (*NEWGen*)
- Corporate strategy
- Natural gas and coal consulting practices
- Access to RDI's industry leading data bases (*POWERdata, BaseCase, POWERmap-GIS*)
- Provided market analysis for refinancing of LUZ parabolic trough Units XIII and IX

Renewable Energy

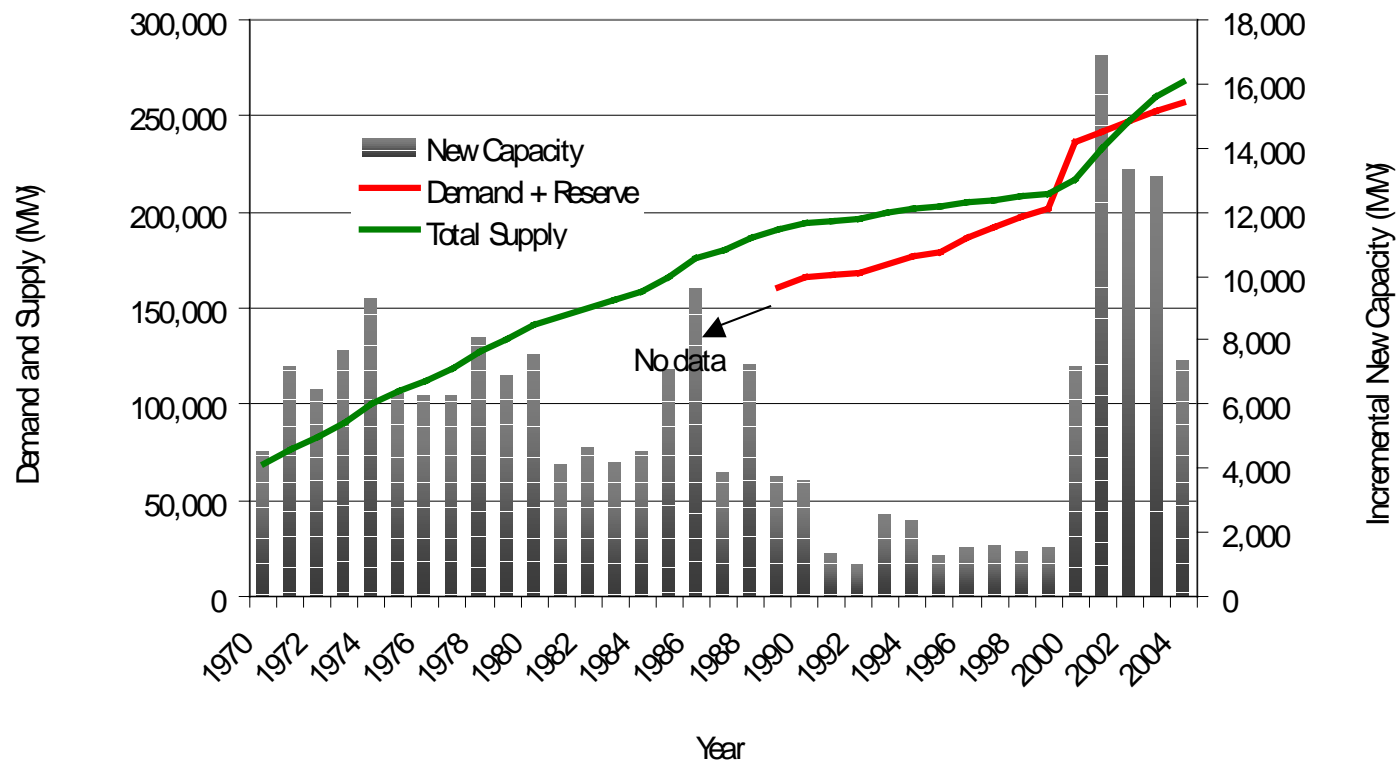
It's wind and solar

- **Wind**
 - Off-the-shelf technology – Plug-and-play, intermittent
- **Solar**
 - Improved technology, new and active players – Great potential, energy can be stored
- **Biomass**
 - Must have agricultural or forestry waste products, “energy crops” are anything but environmental – Causes Emissions
- **Geothermal**
 - Mature technology, need to have geothermal resources, modern drilling techniques can improve potential – Look and you may find.
- **Hydro**
 - No potential for large scale hydro left, significant environmental impact – Not a good choice

Wind and solar are the only important future renewable energy sources in the United States

Demand and Supply

Generating Capacity Additions and Demand Growth in the West, 1970–2004



The Demand and Supply Balance in Detail

The Desert Southwest remains a hot spot in 2001

	Peak Demand (MW)	Available Supply (MW) (3)	Reserve Margin		
			Actual	Target	Surplus (MW)
Northwest	29637 (1)	41,415	42%	29%	3,883
CO and WY	9,782 (2)	11,154	7%	18%	(1,089)
California	52,805 (1)	54,361	3%	16%	(6,893)
Southwest	28,311 (1)	29,979	6%	16%	(2,862)
Prairie States	16,920 (2)	20,169	19%	17%	373
Texas	65,973 (1)	77,100	17%	16%	571
TOTAL/AVERAGE	203,428	234,178	15%	18% (4)	(6,016)

(1) NERC region 2001 summer assessment.

(2) RDI Consulting estimate.

(3) Regionally installed capacity and net imports.

Average weighted by regional peak demand.

Emissions by Generating Technology

Displacement of coal plants by combined cycle plants can reduce plant emissions by 50%

Plant Type	Heat Rate (HHV) Btu/ kWh	NOx Lbs/ MWh	SO ₂ Lbs/ MWh	CO ₂ Lbs/ MWh	Particulates Lbs/ MWh
Coal	9,500 (2)	1.52	1.62	1,930	0.01
Combined Cycle	7,100	0.21	0.01	830	-
Gas Boiler	10,500	0.84	0.01	1,230	-
Combustion Turbine	11,500	0.58	0.01	1,345	-
Solar, Wind, Hydro, and Nuclear	None				

NOTE: U.S. Department of Energy, *Market-Based Advanced Coal Power Systems*, May 1999 and RDI Consulting analysis.

Carbon reductions under the Kyoto Protocol

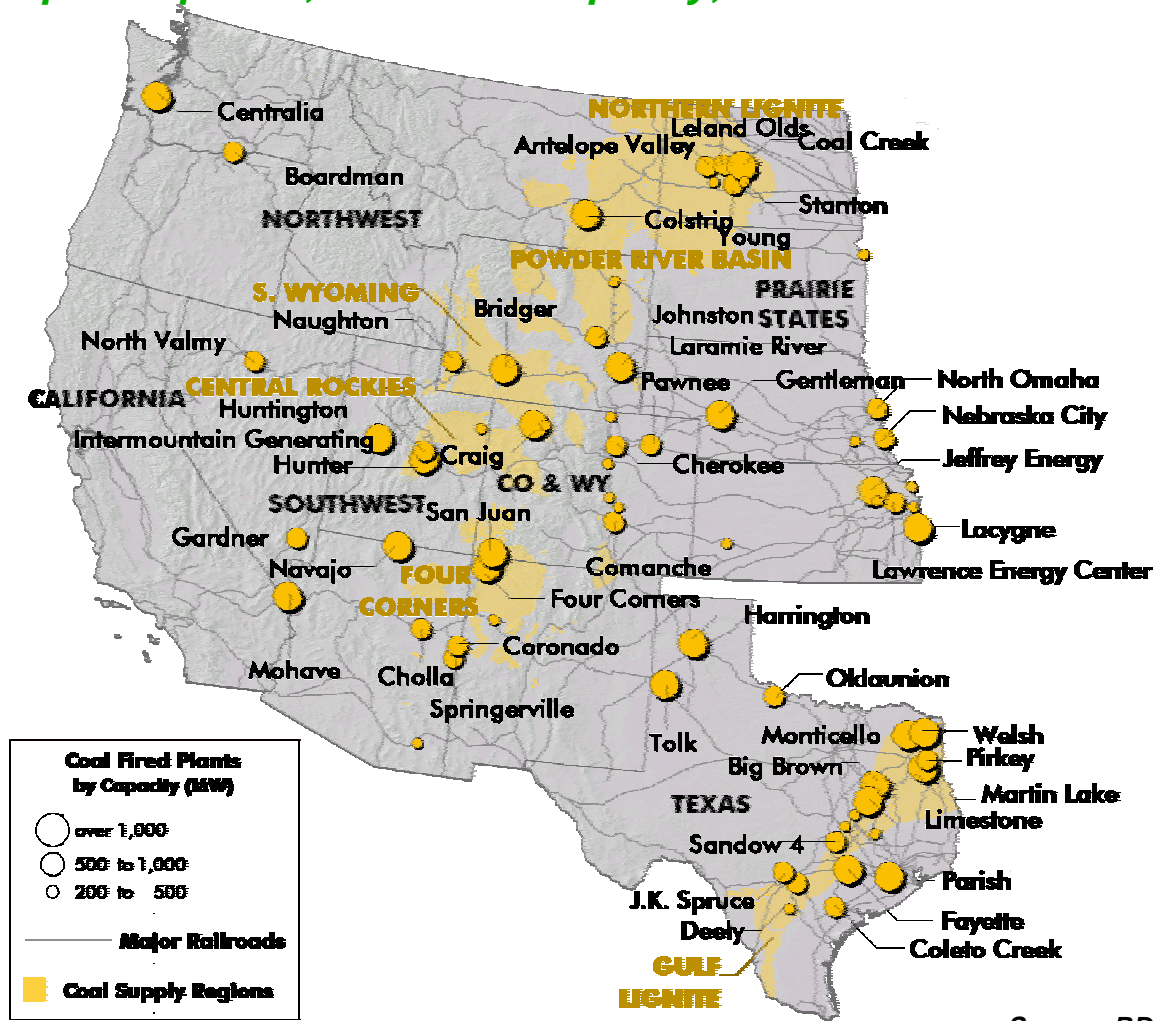
By 2010 the Kyoto Protocol would require carbon dioxide reductions of about 132 million tons in the West

Scenario		Year		
		2001	2005	2010
Basecase Forecast				
CO2 (Million tons)		658	683	746
Change over 2001	Million tons	25		88
	Percent	3.8%		13.4%
Required Change under Kyoto (Million tons) (1)			69	132

- Over 70% of all capacity will be fired by fossil fuels
- About 40-50% will be coal fired.
- To meet the Kyoto protocol a lot of this capacity will have to be replaced by renewables or natural gas.
- Is there enough natural gas at cost that is competitive with renewables, especially wind?

Pollution – Western Regional Air Partnership

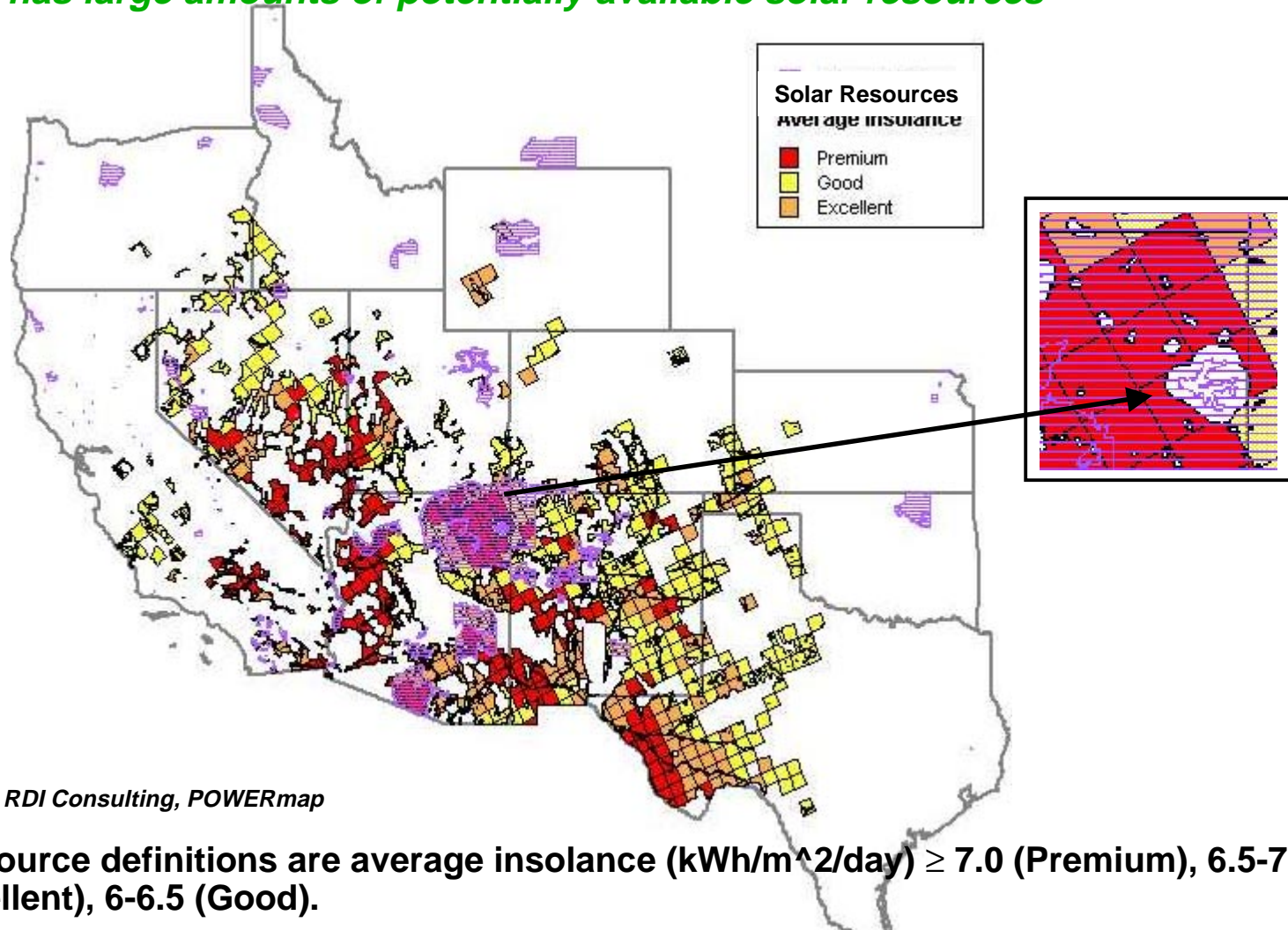
Coal-fired power plants, Western air quality, and solar resources



Source: RDI Consulting, POWERMAP

Where Does the Sun Shine?

The West has large amounts of potentially available solar resources



Source: RDI Consulting, POWERmap

Solar resource definitions are average insolation ($\text{kWh/m}^2/\text{day}$) ≥ 7.0 (Premium), 6.5-7 (Excellent), 6-6.5 (Good).

The Generating Potential

RDI Consulting's methodology for estimating the solar energy potential

- In estimating the solar generating potential we used geographic information systems (GIS) to calculate the amount of potential land for solar power plant development by resource class.
- The GIS data already exclude cities, roads, national parks, crop lands etc. Of the remaining potential land we kept
 - 3% of the area located in premium,
 - 2% in excellent, and
 - 1% in good solar resource areas.
- By keeping an increasing percentage of resource areas with increasing annual solar radiation we reflect the greater interest of solar power plant developers in these areas and the fact the best solar resource areas are typically low-use deserts.
- Assumes installed solar capacity of
 - 5 Acres/MW;
- and the following capacity factors,
 - 25% (Premium),
 - 22.5% (Excellent), and
 - 20% (Good).

The Generating Potential

RDI Consulting's methodology for estimating the solar energy potential

- **2001 Western* electric energy demand is estimated at 1,092,160 GWh. Premium solar resources alone, 1,051,466 GWh, can provide nearly all of this energy.**
- **Premium, excellent, and good resources can provide about twice of Western electricity needs on only 0.5% of Western lands**
- **Analysis assumed the high efficiency and capacity factors of CSP technology**

***Solar power is a real renewable energy
option for the Desert Southwest***

***16 Lower-48 States of the Western Governors' Association**

Displacing existing generation

Land requirements to displace existing generation

2001 Generation by Fuel	GWh	Solar Resources Required		
		% of Premium Resources	(Miles × Miles)	Land as % of Western States
Coal	482,226	46%	41.5 × 41.5	0.10%
Oil and Gas	259,604	25%	30.4 × 30.4	0.05%
Nuclear	124,306	12%	21.1 × 21.1	0.03%
Hydro	199,400	19%	26.7 × 26.7	0.04%
Other	26,625	3%	9.7 × 9.7	0.01%

NOTE: Forecast 2001 generation by fuel type was renormalized to normal hydro and weather conditions.

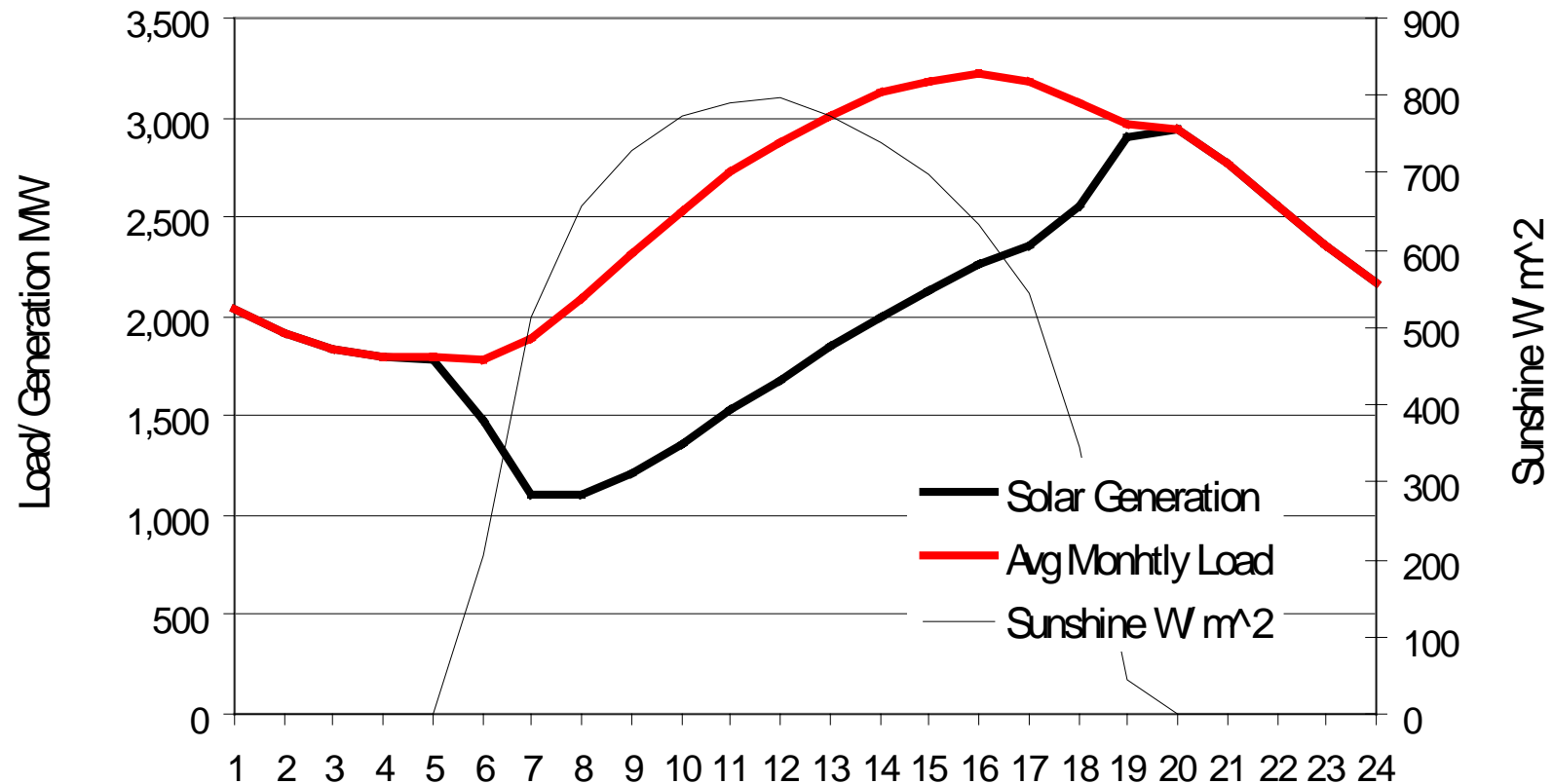
Advantages of Concentrating Solar Power

Ready today, highest efficiency, and lowest cost

- Highest efficiency of all solar generating technologies.
- Cost reductions require no “scientific break-through”, just series production.
- High efficiency makes the use of single and two-axis tracking of the sun worthwhile. This results in high capacity factors.
- High efficiency combined with high capacity factor results in least amount of land required.
- Hybridization with fossil fuel allows to leverage cost of plant and results in favorable project economics.
- Heat storage allows displacement of capacity with pure solar generation.
- Dispatchability of Parabolic Trough and Power Towers plants allows to capture much higher market prices.
- CSP can leverage production capabilities in other industries to produce its equipment. No investment in specialized production facilities necessary. This greatly reduces risk.
- Can bring online hundreds of megawatts of capacity within 2-3 years.
- There is plenty of direct normal radiation. This is not a limitation.

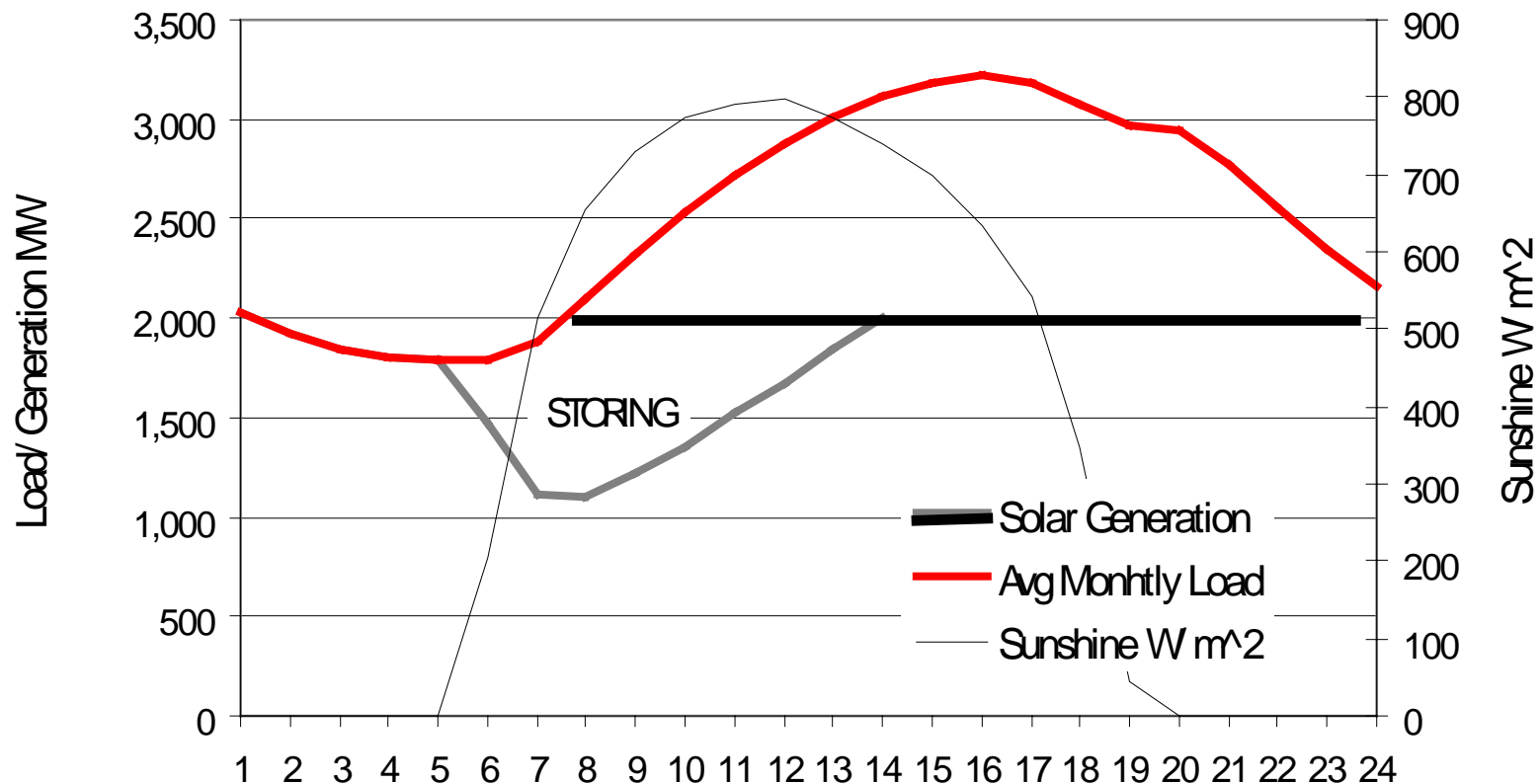
Meeting Electricity Demand

Maximum electricity demand and solar energy production are off-set by a few hours, Nevada Power



Meeting Electricity Demand – Heat Storage

Only 3.5 hours of full-load heat storage of a 1,250 MW solar plant can displace one third of existing capacity in Nevada Power's service territory



CSP Technologies

Ready today, highest efficiency, lowest, cost, and longest track record

- **Dish Stirling**
 - Can leverage high volume production capacity of automotive industry.
 - Requires no cooling water.
 - Smallest space requirements
 - Can be built anywhere in any numbers.
 - Intermittent.
- **Concentrating PV**
 - The future of PV, in our view.
 - Requires some R&D.
 - Direct competitor to Dish Stirling with similar characteristics.
- **Parabolic Trough**
 - Dispatchable with heat storage or fossil hybridization. Access to better market prices.
 - No intermittency issues. Heat storage is the “silver bullet” of intermittent renewable energy sources.
 - Uses hazardous materials, uses herbicides for weed control, uses cooling water as every other steam plant.
- **Power Tower**
 - Also storage and fossil hybridization that maximizes revenues.
 - Highest efficiency thermal storage.
 - No hazardous materials.
 - Potentially lowest cost.

RDI Assessment – What you need to know

Solar power is likely the preferred renewable energy source in the Southwest

- The Southwestern United States potentially has the best solar resources in the world.
- Concentrating solar power (CSP) technologies have the best economics and highest efficiency and are therefore likely to play a dominant role.
- Today's solar power technologies can provide large amounts of reliable electric generation and CSP technologies could provide hundreds of megawatts of solar electric generation within a few years.
- The Western solar generating potential is twice the current electric energy demand, but would only require one half of one percent of Western lands.
- In some areas only a few hours of (heat) energy storage can displace large amounts of conventional generating capacity while providing power reliably.
- This generation can be built on land that is otherwise of low economic and environmental value.

Questions and Answers

On solar power



Electricity Prices and Sunshine

There appears to be no correlation between hourly sunshine and electricity prices

Hourly Load versus Solar Radiation, Southern California Edison, July 1st – September 30th, 1999

